A SPECTROPHOTOMETRIC EVALUATION OF COLOR CHANGE IN DENTAL COMPOSITES DUE TO VARIOUS BEVERAGES BY CIELAB TECHNIQUE–AN IN VITRO STUDY

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in partial fulfillment of the requirements

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BRANCH – IV

CONSERVATIVE DENTISTRY AND ENDODONTICS

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Certificate

This is to certify that **Dr.VARUN RANA,** post graduate student (2008 - 2011) in the Department of Conservative Dentistry and Endodontics,has done this dissertation titled "**A SPECTROPHOTOMETRIC EVALUATION OF COLOR CHANGE IN DENTAL COMPOSITES DUE TO VARIOUS BEVERAGES BY CIELAB TECHNIQUE–AN IN VITRO STUDY "** under our direct guidance and supervision in partial fulfillment of the regulations laid down by **The Tamil Nadu Dr. M.G.R. Medical University, Guindy, Chennai – 32** for **M.D.S.**in Conservative Dentistry and Endodontics (Branch IV) Degree Examination.

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DECLARATION

TITLE OF DISSERTATION	**A SPECTROPHOTOMETRIC EVALUATION OF COLOR CHANGE IN DENTAL COMPOSITES DUE TO VARIOUS BEVERAGES BY CIELAB TECHNIQUE–AN IN VITRO STUDY**
PLACE OF THE STUDY	Tamil nadu Government Dental College & Hospital, Chennai – 3.
DURATION OF THE COURSE	3 YEARS
NAME OF THE GUIDE	DR. S.JAIKAILASH
HEAD OF THE DEPARTMENT	DR. M. KAVITHA

I here by declare that no part of dissertation will be utilized for gaining financial assistance or any promotion without obtaining prior permission of the Principal, Tamil Nadu Government Dental College &HospitaL, Chennai – 3. In addition I declare that no part of this work will be published either in print or in electronic media without the guide who has been actively involved in dissertation. The author has the right to preserve for publish of the work solely with the prior permission of Principal, Tamil Nadu Government Dental College & Hospital, Chennai – 3.

HOD i/c **GUIDE** **Signature of the Candidate**

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CONTENTS

Introduction

INTRODUCTION

The search for an ideal esthetic material for restoring teeth has resulted in significant improvements in both esthetic materials and techniques for using them. Composites and the acid-etch technique represent two major advances.

Composite material is a compound of two or more distinctly different materials with properties that are superior to or intermediate to those of the individual components. Introduced by R. L Bowen[45] in 1962 with continuous research and development is now used in all restorative conditions with advantages –

1. Excellent aesthetic properties, which can match the colour of natural tooth.

2. Conservative tooth structure removal (less extension; uniform depth not necessary; mechanical retention usually not necessary)

3. Bonded to tooth structure, resulting in good retention, low microleakage, minimal interfacial staining,and increased strength of remaining tooth structure

4. Repairable

As these are direct esthetic restorative material the success of this restoration depends largely on their colour stability and their finishing surface.Change of color and loss of shade-match with surrounding tooth structure are reasons for replacing restorations. Important factors that affect stainability are surface roughness, surface integrity, and polishing technique. Various finishing and polishing techniques have been examined with different types of resin composite to produce a smooth surface [28].

However, a major disadvantage is their discolouration after prolonged exposure to the oral environment. The color changes associated with composite resins can be either extrinsic, intrinsic or idiopathic in origin. Impregnation from food and beverage pigments is considered the main extrinsic pigmentation factor.

1]Adsorption or absorption of staining agents such as red wine, coffee, tea, and cola may cause discolouration.[52]

2]Oral habits such as tobacco use and certain dietary patterns (for example, caffeine intake) may exacerbate the external discolouration of resin based composites.

Tea, coffee, and wine are commonly consumed beverages in Indian population.These beverages have ability to stain the restorative material and hence an evaluation on the surface changes on different composites is needed.

Aim & Objectives

AIM AND OBJECTIVES

The aim of this study is to evaluate the –

1] Color stability of four different composites [HYBRID, NANO COMPOSITE, NANO CERAMIC, NANO HYBRID COMPOSITES] after exposure to commonly consumed beverages [TEA,COFFEE,WINE]

2] Type of beverage influence in staining of resin composites.

Review of Literature

REVIEW OF LITERATURE

W.H. DOUGLAS and R.G. CRAIG [1982] stated that aged specimens stain more readily and are more resistant to hygiene procedures. Fluorocarbons resist the effect of aging at high humidity. The original interest in the fluorocarbon polymers as a matrix for composites was in their ability to resist microleakage;however, the results of this study suggest that their ability to resist extrinsic stains may also be an important asset.[13]

Van Groeningen et al. [1986] in his study stated that coffee may stain by adsorption and by absorption of its colorants into the organic phase of resin composites. The presence of sugar in coffee increased the colour difference compared to coffee without sugar for light-polymerized composite provisional material and micro hybrid composites.[50]

MAIR L.H [1995]stated that composite restorations discolor as a result of the ingress of stains. This effect may be most noticeable in the unfilled resin layer surrounding the restorations. The degree of marginal stain depends upon the thickness of the unfilled layer, and also its permeability. The hydrophilic qualities of the resins may contribute to the staining of the unfilled layer, whereas in composites it is affected by the solubility of the glass fillers.

Marginal stain can be minimized by keeping the unfilled layer as thin as possible and avoiding the use of hydrophilic resins.[31]

Fay RM et al [1999] evaluated the color stability of a polyacid-modified composite (compomer) upon exposure to stains. At 24 hours, perceptible color changes occurred for specimens in red wine and coffee. After 48 hours, perceptible color changes occurred for specimens in cola. Chlorhexidine and water caused no perceptible color changes. They stated that compomer is susceptible to staining by coffee, red wine, and cola.[16]

Tsun Ma, DMD, Glen H et al[1999] evaluated whether chemical disinfectants affected the surface texture and color of 3 fixed prosthodontic materials.There were no statistical differences in surface roughness among disinfectants and restorative materials. However, there were statistical differences of changes in color, increase in ΔE and decrease in ΔL, among disinfectants and the noble casting alloy.They concluded that only 2 of the 3 materials evaluated , Dicor and Vita VMK ceramometal porcelain, can be used with all 5 disinfectants up to 7 days of immersion. Three chemical disinfectants (Biocide, Clorox, and Multicide) caused clinically significant color changes with the noble casting alloy after 7 days of immersion.[30]

Panzeri H, Fernandes LT, Minelli CJ. [1977] stated that ideal restorative materials should have fluorescence similar to that of natural teeth.If an esthetic restorative material does not emit fluorescence, the esthetic qualities of the restorations suffer under predominantly UV illumination conditions (black light). Restorations should match the color of the natural teeth not only in daylight, but also under different light sources.[35]

Powers JM.et al [2000] determined the color stability of a compomer, hybrid ionomer, and composite after staining with three fluoride varnishes.Varnishes Duraflor and Duraphat caused perceptible color changes (delta E* > 3.3) in compomer, hybrid ionomer, and composite after application; however, FluorProtector did not affect the color of the materials. After brushing, none of the materials exhibited perceptible values of delta E*, except the composite with Duraflor. [39]

Abu-Bakr N, Han L, Okamoto A, Iwaku M [2000] stated that compomer and resin-modified glass ionomer were susceptible to discoloration in various solutions over an extended period of time. [3]

Stober T, Gilde H, Lenz P [2001] studied the effects of different drinks on stainability of composite resin provisional restorative materials .It was found that red wine caused the most severe discoloration when red wine, tea, coffee, mouthrinse, and UV irradiation were used as staining agents to evaluate the stainability of composite materials.[44]

Tung et al., 2002 stated that digital equipment used for color analysis is more precise and consistent than human vision because it can analyze color without human influence bias.[47]

Wolfgang Buchalla, et al [2002] determined color and translucency changes in a hybrid(Tetric) and a microfilled (Silux Plus) composite after light exposure with and without water storage. They concluded that resin-based restoration materials undergo measurable changes due to daylight exposure. Increased changes occurred under the influence of water storage.[10]

Lee YK, Lim BS, Powers JM [2004] evaluated the color change of dental resin composites immersed in a salivary enzyme of esterase compared to those immersed in phosphate-buffered saline (PBS). Discoloration generally increased as the immersion period increased. For one composite, the value increased abruptly in the period of 3 days to 3 weeks of immersion. The change in Ra value after immersion was varied by the composite and shade. VHN decreased significantly after immersion in ETE for nine weeks. Immersion in PBS resulted in decreased VHN in two composites.12

Patel SB, Gordan VV et al [2004] investigated the staining capacity of unfilled resins and resin-based composites.They concluded that though unfilled resin has more resin matrix present than does resin based composite,unfilled resin specimens generally exhibited less colour changes than did resin based composite specimens, with the exception of specimens immersed in cola solution. This deviation also demonstrated the critical role of the composition of the staining solution on the colour changes.[37]

Alves et al. [2004] stated that amazonian fruits pigments such as açaí and energetic guaraná, can discolor teeth and restorations. [5]

Khaja Iftheqar Ahmed, Girija Sajjan[2005] stated that in ethanol, RMGI showed a perceptible color change, therefore when a RMGI restoration is placed; ethanol containing mouth rinses should be avoided. If the patients are a habitual drinker then Glass ionomer or Resin based composites may be used as even compomer showed a slightly perceptible color change.

In acetic acid (present in plaque, diet), Glass ionomer showed the maximum color change followed by compomer. Though RMGI showed color change, it was lesser when compared to GI or compomer.

Therefore if a fluoride containing restorative has to be placed then RMGI would be the material of choice and since RMGI has a tendency to be come lighter in Acetic acid, a slightly darker shade may be selected in such a situation.

In hydrogen peroxide (patients indicated for bleaching), GI completely dissociated, RMGI showed varying amounts of color change with delamination of the surface. Compomer showed a perceptible color change. The best material would be Resin based composite. But if a fluoride- containing restorative is demanded in a situation, then compomer would be the next best material of choice.

Since compomer had the tendency to lighten and become bluish, a slightly darker and yellower shade may be selected in such a clinical situation.Resin based composites[RBC] showed the best results in terms of color stability, hence if the situation is not very insisting on the fluoride containing esthetic restorative then RBC showed be used. [22]

R Gupta, H Parkash, N Shah [2005] did a study to compare the color stability of a porcelain (Vitadur alpha) and two universal composites (Filtek Z 250 and Tetric Ceram) after exposure to commonly consumed beverages i.e. tea, coffee, coca-cola and distilled water (as control) by using a reflectance spectrophotometer and CIELAB system. They concluded that the color match of esthetic restorations in the oral cavity is affected by dietary habits. [21]

Lee, Y.-K. et al (2005), evaluated the color change of dental resin composites following a series of immersion treatments, especially in organic substances. Combined treatment with mucin (or serum) with CH (or CP) did not produce significantly higher color changes compared to controls ($p > 0.05$). Mucin-treated composites showed generally lower methylene blue staining compared to serum and PBS groups. Although combined treatment of organic substances and chemical agents resulted in various discolorations of resin composites, chemical alteration of organic substances did not produce higher color change compared to PBS controls. [25]

Ahmet Umut Guler,Fikret Yilmaz et al [2005] stated in their study that the reinforced microfill restorative material tested was found to be more color stable than the autopolymerized,light-polymerized composite provisional restorative materials, and microhybrid composites tested. The largest color difference was observed in the light-polymerized composite provisional material.These differences were found to be significantly different.[24]

Patricia Villalta, Huan Lu et al [2006] investigated the effects of 2 staining solutions and 3 bleaching systems on the color changes of 2 dental composite resins. They concluded that the nanocomposite (FS) changed color more than microhybrid composite (EX) as a result of staining in coffee or red wine solutions. After bleaching, discoloration was removed completely from the composite resins tested.[38]

Yong-Kyu Lim, Yong-Keun Lee [2007] stated that fluorescent emission was influenced by the brand and the shade of resin composites.Fluorescent resin composites showed color shift to blue direction and increased lightness under the UV included illumination. [55]

Ertan ERTA , Ahmet Umut GÜLER et al [2006] evaluated the discoloration of two nanohybrids, two microhybrids, and a posterior composite resin restorative material upon exposure to different drinks — namely tea, cola, coffee, red wine, and water. For all the materials tested, their color change in staining agents ranked in this increasing order: water < cola < tea < coffee < red wine. In terms of comparison among the five restorative materials, Filtek P60 and Z250 were observed to manifest less color change than the nanohybrids and Quadrant LC. [15]

Yong-Keun Lee et al [2007] concluded that the included percentage of UV component of the daylight simulator(illuminant D65) significantly influenced the color of fluorescent composite resins tested, Palfique Estelite S, Point 4, and Vit-l-escence, but did not influence the color of nonfluorescent or limited fluorescent composite resin tested (Filtek Supreme).[54]

Ayad NM [2007]determined the staining potential of glass-ionomer and composite resin restorative materials following immersion in common beverages. The delta E was significantly higher for coffee and tea than for cola; the deltaE was significantly higher for the polyacid-modified composite resin than for all other materials. The material with the least amount of color change in coffee and tea was the ceramic-reinforced glass ionomer (deltaE = 12.45 and 10.64, respectively) and in cola was the nanofilled composite resin (deltaE = 1.93) [7]

JOSEPH B. DENNISON, JOHN M. POWERS et al [2007] stated that there were observable color variations among the 11 resins studied, but only 3 materials were within the range of natural tooth color. Values of luminous reflectance, dominant wavelength, and excitation purity were higher for the resins tested when measured against a white as opposed to a black background. The contrast ratio of samples 1.3 mm thick ranged* F from 0.587 to 0.742 for the composite resins and from 0.102 to 0.317 for the coatings. Only 3 of the "universal" shades of the composite resins tested were observed in the value, hue, and chroma reported for natural teeth. [29]

R.D. Paravina, S. Westland, W.M. Johnston and J.M. Powers [2008] – concluded that within the limitations of this study, a newly developed concept and equation have proved the existence of the physical component of color adjustment of translucent dental materials. They facilitated the differentiation of this highly desirable esthetic property, thus promoting its use as a relevant tool for quantification of color adjustment potential in dentistry. Overall, the highest color adjustment potential was recorded for Estelite , followed by 4 Seasons, Gradia Direct,Esthet-X, Renamel Microfill, Venus, and Heliomolar, in decreasing order.[36]

Débora da Costa e Silva et al [2009] evaluated in vitro the color stability of composite resins(Natural Look, Z350, 4Seasons and Opallis) when exposed to beverages with high coloring contents from the Amazon region. They concluded that none of the tested composites showed color stability when exposed to coloring solutions, and that the Amazon region beverages (açaí juice and energetic guaraná) showed to be less coloring than coffee. [12]

Fulya Toksoy Topcu et al [2009] Within the limitations of this study, the following conclusions were drawn:1. Nano composite material, Filtek Supreme was found to have the least discolouration among the all restorative materials tested.These differences were found to be significantly different.

2. Colour change values of artificial saliva,granule lemon juice, coffee, coca cola, sour cherry juice, fresh carrot juice and red wine groups of resin-based

composites were smaller than or equal to $\Delta E= 3$. Red wine and coffee have higher colour change than others.

3. Red wine produced the most discolouration results in three of the four resin based composite materials tested. [18]

Bong-Joon Kim, Yong-Keun Lee (2 0 0 9) measured the difference in color and color coordinates between the same shade-designated resin composites from different brands, and determined the influence of shade designation on the difference in color and color coordinates between them. With regard to the mean $E*ab$ value of each shade designation,all the values except for the A2-designated shade were higher than the perceptible threshold ($E*ab > 3.7$). 42 among a total of 83 shade pairs (49%) showed clinically perceptible color discrepancy ($E*ab > 3.7$). L* and a* were not influenced by the shade designation of resin composites; however,b* and $E*ab$ were influenced by the shade designation .[9]

Yo OMATA, Shigeru UNO· [2010] examined the surface staining mechanism of a photopolymerized composite by coffee, oolong tea, and red wine. They stated that common drinks stained the dental composite, but each by a specific mechanism that depended on external conditions such as the presence of chlorhexidine.[52]

Maria Anagnostou et al [2010] stated in their study that after 2-week bleaching cycles, composites showed significant gloss reduction ($p < 0.05$). Color alteration was below the 50:50% acceptability threshold ($DE^* < 3.3$) and it was product-depended. There was no significant difference in color and gloss changes between the evaluated bleaching strips and 10% carbamide peroxide gel.[32]

Q. Li , B.T. Xu , R. Li, Y.N. Wang et al [2010] stated that the color and the translucency of translucent composites are different from the teeth enamel.[40]

Marıa M. Perez et al [2010] stated that the new silorane-based restorative system showed different optical properties compared to clinically successful dimethacrylate composites. The silorane composite exhibited better polymerization-dependent chromatic stability, and a lower translucency compared to other tested products.[33]

Materials & Methods

ARMAMENTARIUM & MATERIALS USED IN THIS STUDY

- HYBRID COMPOSITE RESIN— CHARISMA [HERAEUS KULZER GmbH, Shade A3, LOT 010303]
- NANO HYBRID COMPOSITE RESIN—TETRIC N CERAM [IVOCLAR VIVADENT,Shade A3, LOT N 25871]
- NANOCOMPOSITE RESIN—FILTEK Z 350 [3M ESPE, Shade A3 LOT 188857]
- NANO CERAMIC COMPOSITE – CERAM X [DENTSPLY, Shade A3, LOT 0906000926]
- Glass slab
- Mylar strip
- Glass slide [1mm thickness]
- Custom made Teflon ring [10mm diameter, 2.5mm thickness]
- Quartz tungsten halogen curing light [CD 100, DENTSPLY]
- Gretag Reflectance Spectro photometer
- Teflon coated instrument
- Water resistance marker pen
- Incubator

COMPOSITION

1] CHARISMA -- BIS GMA Matrix and contains 58% filler [by volume] which is barium aluminium fluoride Glass [0.002 -2 microns],highly dispersive silicium dioxide [0.02 -0.07 microns]

2] CERAM X [DENTSPLY] -- methacrylate modified polysiloxane, dimeth acrylate resin, fluorescence pigment, UV stabilizer, camphoroquinone, Ethyl -4 [dimethyl amino] benzoate, Barium aluminium boro silicate glass, silicon dioxide nano filler, iron oxide pigments and titanium oxide pigments and aluminium sulfo silicate pigments.

3] FILTEK Z350 [3M ESPE] – Aggregated zirconia/ silica cluster filler with average cluster particle size of 0.6 – 1.4 microns with primary particle size of 5.20nm and a non agglomerated/ non aggregated 20nm silica filler. Bis GMA,UDMA,TEG DMA ,and bis EMA resins.

4[TETRIC N CERAM [IVOCLAR] -- Paste of dimethacrylates, inorganic fillers, ytterbium trifluoride,initiators, stabilizers and pigments.

Five different solutions serving as staining agents used are :

DISTILLED WATER, TEA, COFFEE, RED WINE ,AND ARTIFICIAL SALIVA.

SPECIMEN PREPARATION

Two hundred disk samples (50 disk of each material at a diameter of 10 mm anda thickness of approximately 2.5 mm) of shade A3 were fabricated by condensing the composite material into ring shaped Teflon mould by using Teflon coated instrument ,covered by mylar strip and pressed flat using hand pressure with help of glass slide to extrude excess material and to obtain a smooth surface. Extra flash was removed and material was made flush with the top of the mold surface.

Curing was done by using Quartz tungsten halogen curing light [CD 100, DENTSPLY].For Nanocomposite resin curing was done for 40 seconds as per manufacturers recommendation.

For Nano hybrid composite resin curing done for 20 seconds

For Nano Ceramic composite curing done for 20 seconds

For Hybrid composite resin curing was done for 20 seconds.

No polishing technique were used to avoid modification of the surfaces, which may have influenced the results .The specimen were incubated in 100% humidity at 50°C for 24 hours in an incubator.

They were divided into 4 groups :

Group A – NANO COMPOSITE RESIN -- NC

Group B - NANO HYBRID COMPOSITE RESIN—NH

Group C - NANO CERAMIC COMPOSITE – NCC

Group D - HYBRID COMPOSITE RESIN— HC

PREPARATION OF BEVERAGES

TEA -- Tea solution was prepared by immersing popularly used two prefabricated tea bags [2x2gms] into 350ml of boiling water for 3 minutes. The solution was stirred for 1 minute and then filtered.

COFFEE -- To prepare the coffee solution,5 g of popularly used instant coffee was poured into 350ml of boiling water. After stirring for one minute ,the solution was filtered by using filter paper .The solutions were prepared daily.

RED WINE popularly available in market was used.

ARTIFICIAL SALIVA –Ingredients carboxy methyl cellulose 4gms, sorbitol 60gms, potassium chloride 1gms, sodium chloride 1gms, sodium fluoride 2gms, magnesium chloride 50mg, calcium chloride 150mg, potassium phosphate 400mg. Distilled water was added to produce 1000ml.pH 6.5

IMMERSION OF SPECIMENS IN BEVERAGES

To evaluate the color stability of four composites in different beverages, 50 specimens of each group were subdivided into 5 subgroups of 10 specimens, which were immersed in one of the following beverages :

SUB GROUP A - DISTILLED WATER (CONTROL)

SUB GROUP B – WINE

SUB GROUP C -TEA

SUB GROUP D – COFFEE

SUB GROUP E –ARTIFICIAL SALIVA

COLOR CHANGE MEASUREMENT

10 specimen of each composite material disc was selected. The discs were marked with a water resistant marker on one side so that the opposite non marked surface would be measured each time and were numbered to avoid confusion in subsequent readings .

The prepared composite discs were placed in distilled water and the specimen were incubated in 100% humidity at 37°C for 24 hours in an incubator.

The base line color values [L,A,B] of each specimen was measured with a spectrophotometer according to Commission Internationale d'Eclairage [CIELAB]. The spectrophotometer was calibrated with a standard white card before each group of specimen was measured,and the card was used as a background when measuring all specimen.

Color was measured according to the CIELAB color scale relative to the standard illuminant D65 over a white standard tile (CIE L = 82.3, A =−0.1 and B =−0.6) on a reflection spectrophotometer (Color-Eye 7000A, GretagMacbeth Instruments Corp., New Windsor, NY, USA) using Optilight color matching and analysis soft ware.

The aperture size was 3mm×8mm, and the illuminating and viewing configuration was CIE diffuse/8° geometry.

The measurement were repeated twice in each sample and the mean value was calculated. After taking baseline color measurements, discs were immersed in staining solutions of tea, coffee, wine ,artificial saliva and in distilled water [control] and measurements were made after 1week,2 week and after 3 weeks. 15 ml of anti microbial solution [Cetrimide ,Cetab pharma] was added to each 350ml of test solution to prevent any microbial growth.

Following removal from the staining solutions, the samples were dipped in distilled water and moved up and down five times. The samples were then wiped dry with tissue paper and then placed in viewing port for color measurement. Color-Eye 7000A Gretag Macbeth (Reflection spectrophotometer) was used in the study.

Using the values of L^*, A^*, B^*, differences between the first measurement and the time- dependent measurements were calculated as the color difference values ΔL^*, ΔA^*, ΔB^*.

For example, the formula for ΔL^* was as follows:

$\Delta L^*(t) = L^*(t) - L^*(0)$

where *L*(t)* is the L* value measured at time *t* and *L*(0)* is the L* value from the first measurement (baseline value, time = 0).

To derive an overall color change, ΔE (t) at time *t* was calculated as follows according to CIE :

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta A^*)^2 + (\Delta B^*)^2}$$

FIGURE 1: MATERIALS AND METHOD

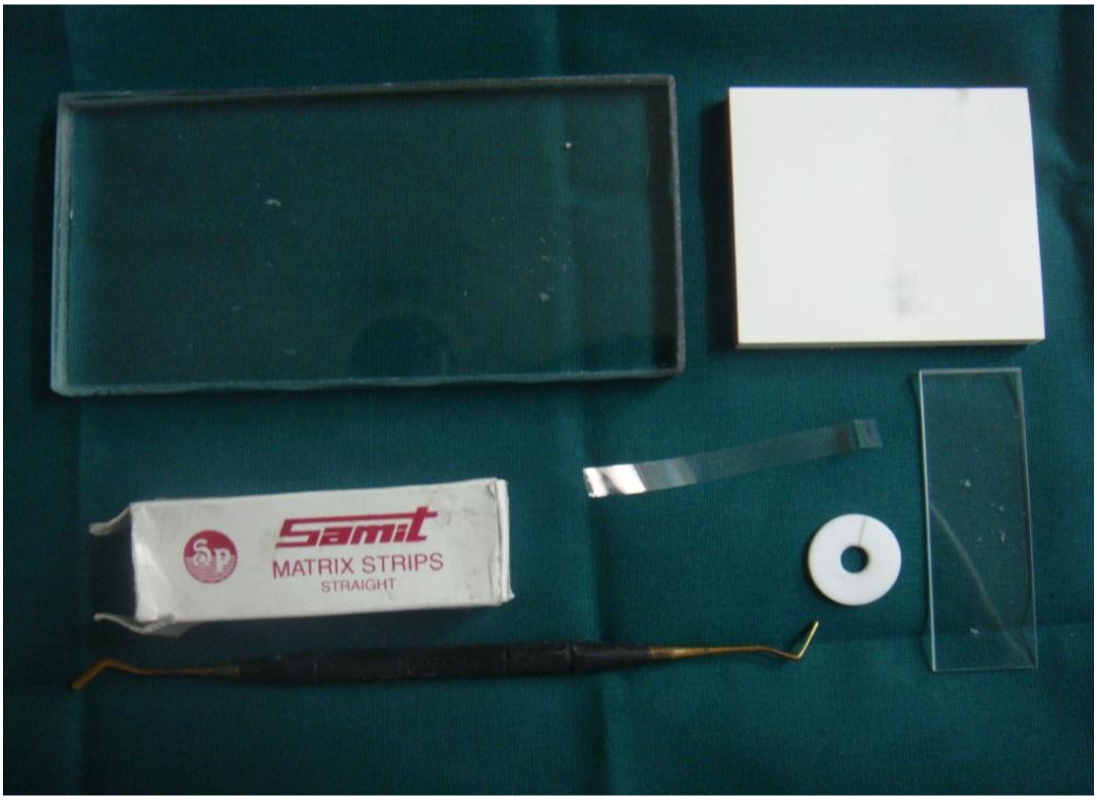


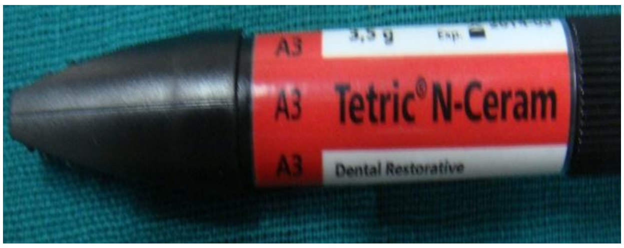
FIGURE 2 :INCUBATOR

FIGURE 3: DIFFERENT COMPOSITION OF COMPOSITES USED

HYBRID COMPOSITE RESIN

NANO CERAMIC COMPOSITE

NANO COMPOSITE RESIN

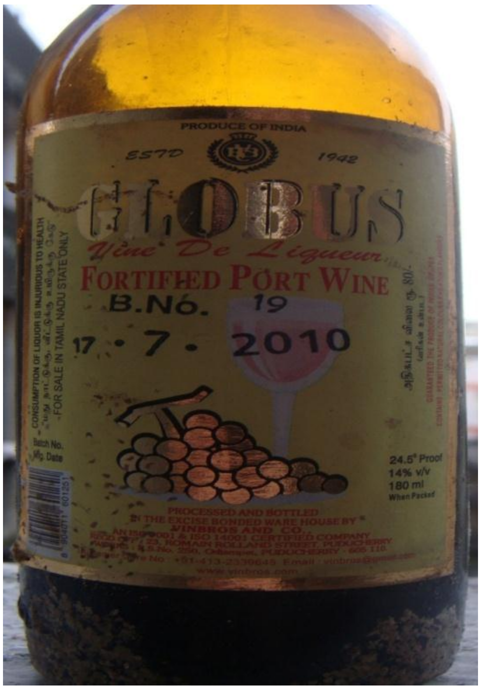


NANO HYBRID COMPOSITE RESIN

FIGURE 4

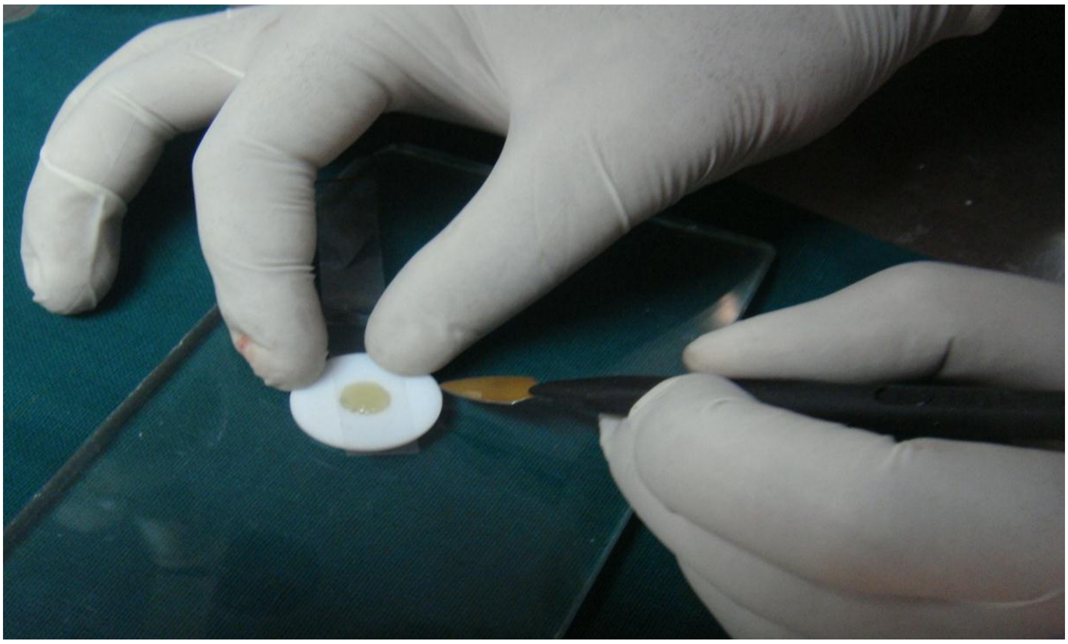
TEA BAGS [2 GRAMS]

[COFFEE 5 GRAMS]



WINE

FIGURE 5 : FABRICATION OF SAMPLES



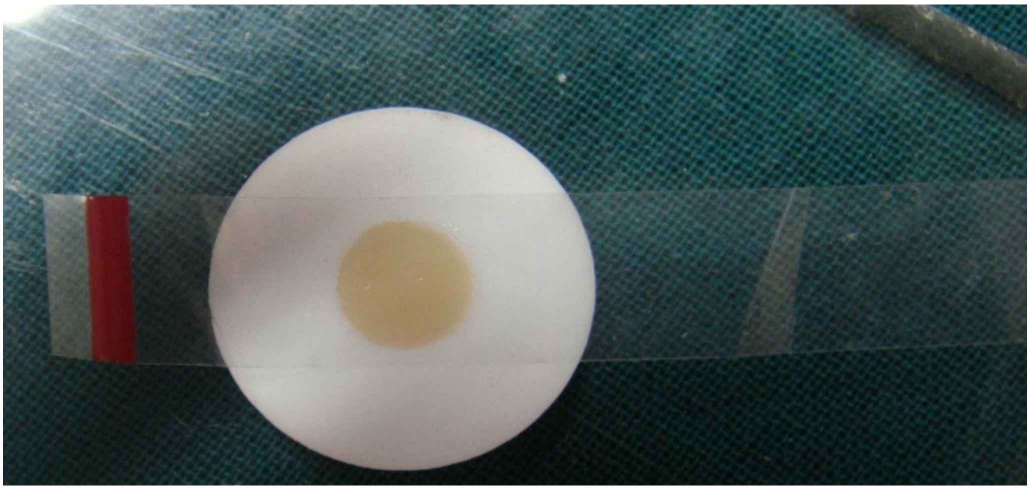


FIGURE 6 : FABRICATED SAMPLES

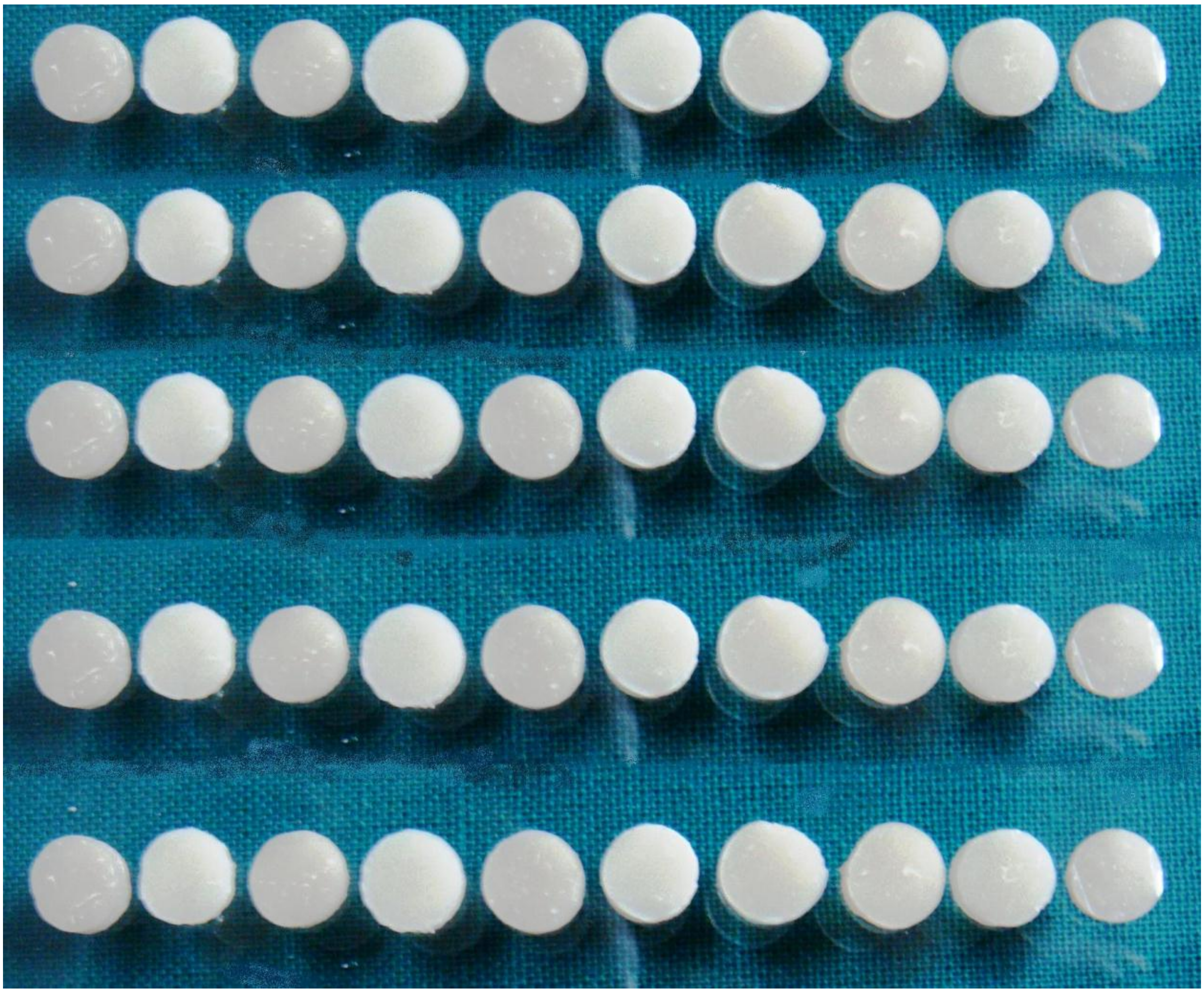
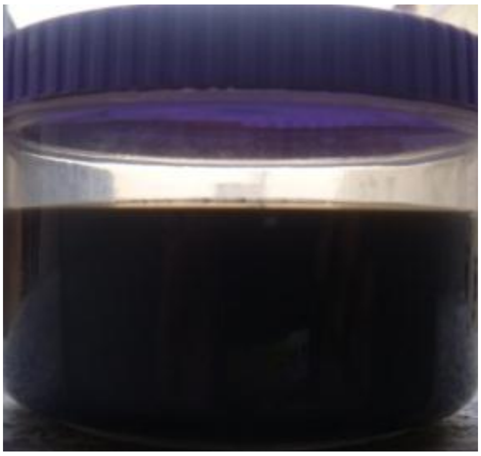


FIGURE 7 : PREPARED SAMPLES IMMERSED IN DIFFERENT SOLUTIONS

DISTILLED WATER **ARTIFICIAL SALIVA**



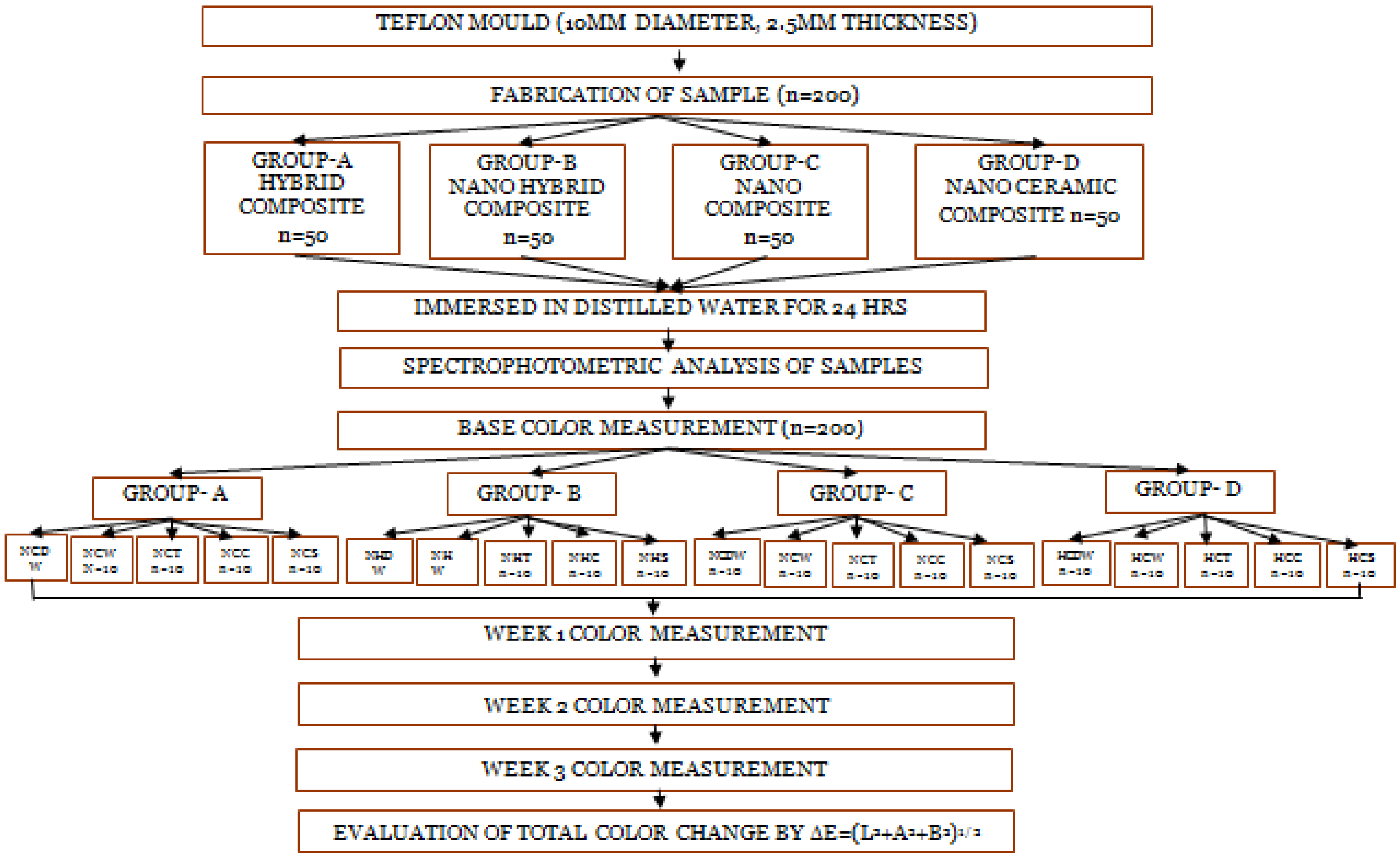
TEA **COFFEE**

WINE

FIGURE 8 : GRETAG REFLECTANCE SPECTROPHOTOMETER

FIGURE 9: COLOR CHANGE IN ARTIFICIAL SALIVA [MINIMUM]

FIGURE 10 : COLOR CHANGE IN TEA [MAXIMUM]


TEFLON MOULD (10MM DIAMETER, 2.5MM THICKNESS)
FABRICATION OF SAMPLE (n=200)
GROUP-A HYBRID COMPOSITE n=50
GROUP-B NANO HYBRID COMPOSITE n=50
GROUP-C NANO COMPOSITE n=50
GROUP-D NANO CERAMIC COMPOSITE n=50
IMMERSED IN DISTILLED WATER FOR 24 HRS
SPECTROPHOTOMETRIC ANALYSIS OF SAMPLES
BASE COLOR MEASUREMENT (n=200)
GROUP- A
GROUP- B
GROUP- C
GROUP- D
WEEK 1 COLOR MEASUREMENT
WEEK 2 COLOR MEASUREMENT
WEEK 3 COLOR MEASUREMENT
EVALUATION OF TOTAL COLOR CHANGE BY ΔE=(L²+A²+B²)^1/2

Results

RESULTS

TABLE I shows mean values of color change [ΔE] of different composite resin group after exposure to different beverages after 1 week ,2 week and 3 week and is graphically represented in Graph I. The values of ΔL*, ΔA* and ΔB* for all the groups at different time intervals in various beverages is given TABLE II,III,IV,V and VI.

When color change of different composite materials is considered, overall maximum discolouration was seen in NANO CERAMIC COMPOSITE (mean ΔE=4.78) and minimum in NANO COMPOSITE [mean ΔE=2.05].

Among solutions in which specimens were immersed maximum mean value was seen with TEA [ΔE=6.85]and minimum in ARTIFICIAL SALIVA [ΔE=1.80]

ΔL* (BRIGHTNESS) VALUES – Positive ΔL* indicates that the specimens became lighter, whereas negative ΔL* indicates that the specimens became darker All the specimens became darker after immersion in solutions with increase in duration. A maximum change in ΔL* was seen in Group C NANO CERAMIC COMPOSITE [mean = -10.87] after exposure to TEA.

ΔA* (CHANGE ALONG RED-GREEN AXIS) VALUES- Negative Δa* indicates a shift towards green color whereas positive Δa* indicates a shift towards red color. A maximum change in ΔA* was seen in Group C NANO CERAMIC

COMPOSITE [mean = 2.70] after exposure to COFFEE. Nano composite showed positive ΔA in all sub groups.. Nano hybrid composite showed positive ΔA distilled water, wine, tea and artificial saliva but negative ΔA in coffee. Nano ceramic composite also showed positive ΔA distilled water, wine, tea and artificial saliva but negative ΔA in coffee. Hybrid composite showed positive ΔA in all sub groups.

ΔB* (CHANGE ALONG YELLOW-BLUE AXIS) VALUES - Positive Δb* indicates a shift towards yellow color while negative Δb* denotes a shift

towards blue color. Maximum color change was in Group B NANO HYBRID[1.64] in COFFEE in 3 week.Nano composite showed positive B in distilled water,wine,coffee and artificial saliva but negative value in tea.

Nanohybrid showed negative value in distilled water,wine,tea and coffee but positive value in artificial saliva. Nanoceramic composite showed positive value in distilled water but negative value in wine ,tea, coffee, and artificial saliva.

Hybrid composite showed positive value in distilled water, wine, coffee but negative value in tea and artificial saliva.

(TABLE I) MEAN VALUES OF COLOR CHANGE [ΔE] OF DIFFERENT COMPOSITE RESIN GROUP AFTER EXPOSURE TO DIFFERENT BEVERAGES

Solution / Materials	DISTILLED WATER			WINE			TEA			
	I week	14 Days	21 Days	7 Days	14 Days	21 Days	7 Days	14 Days	21 Days	7 Days
NC	1.62	2.21	2.22	1.54	1.91	3.05	2.59	3.31	3.61	0.91
NH	1.85	1.73	2.46	2.29	2.92	3.53	1.06	1.88	2.91	2.24
NCC	0.84	1.42	2.62	2.47	2.96	3.46	11.93	12.81	13.41	1.88
HYBRID	2.33	2.33	3.10	1.36	2.72	3.18	8.89	9.54	10.23	1.39

(TABLE II) - MEAN VALUES OF COLOR CHANGE [ΔE] OF DIFFERENT COMPOSITE RESIN GROUP AFTER EXPOSURE TO DISTILLED WATER

Material / Day	NC			NH			NCC			HYBRI	
	ΔL	ΔA	ΔB	ΔL	ΔA	ΔB	ΔL	ΔA	ΔB	ΔL	ΔA
1 WEEK	-1.01	0.73	0.28	-0.47	0.68	0.77	-0.33	-0.10	-0.39	-0.81	0.05
2 WEEK	-1.85	0.80	0.46	-0.99	0.90	0.12	-1.11	0.49	-0.17	-1.58	0.04
3 WEEK	-1.96	0.86	0.23	-1.69	1.51	-0.54	-2.23	0.92	0.62	-2.51	0.12

(TABLE III) - MEAN VALUES OF COLOR CHANGE [ΔE] OF DIFFERENT COMPOSITE RESIN GROUP AFTER EXPOSURE TO WINE

Material / Day	NC			NH			NCC			HYBRI	
	ΔL	ΔA	ΔB	ΔL	ΔA	ΔB	ΔL	ΔA	ΔB	ΔL	ΔA
1 WEEK	-1.42	0.21	0.24	-1.64	0.08	0.07	0.28	-0.14	-0.86	-1.03	0.12
2 WEEK	-1.74	0.20	0.36	-2.33	0.40	0.01	-0.19	0.12	-0.88	-2.15	-0.16
3 WEEK	-2.25	0.35	0.03	-2.87	1.02	-0.60	-0.74	0.57	-1.56	-2.66	0.18

(TABLE IV) - MEAN VALUES OF COLOR CHANGE [ΔE] OF DIFFERENT COMPOSITE RESIN GROUP AFTER EXPOSURE TEA

Material / Day	NC			NH			NCC			HYBF	
	ΔL	ΔA	ΔB	ΔL	ΔA	ΔB	ΔL	ΔA	ΔB	ΔL	ΔA
1 WEEK	-1.05	0.54	-1.91	-0.44	-0.13	0.14	-9.28	0.35	-5.44	-7.72	0.7
2 WEEK	-1.85	0.69	-2.20	-1.35	0.55	-0.70	-10.32	0.62	-6.30	-8.58	1.1
3 WEEK	-2.10	0.94	-2.29	-2.23	0.86	-1.21	-10.87	0.75	-6.84	-9.25	1.3

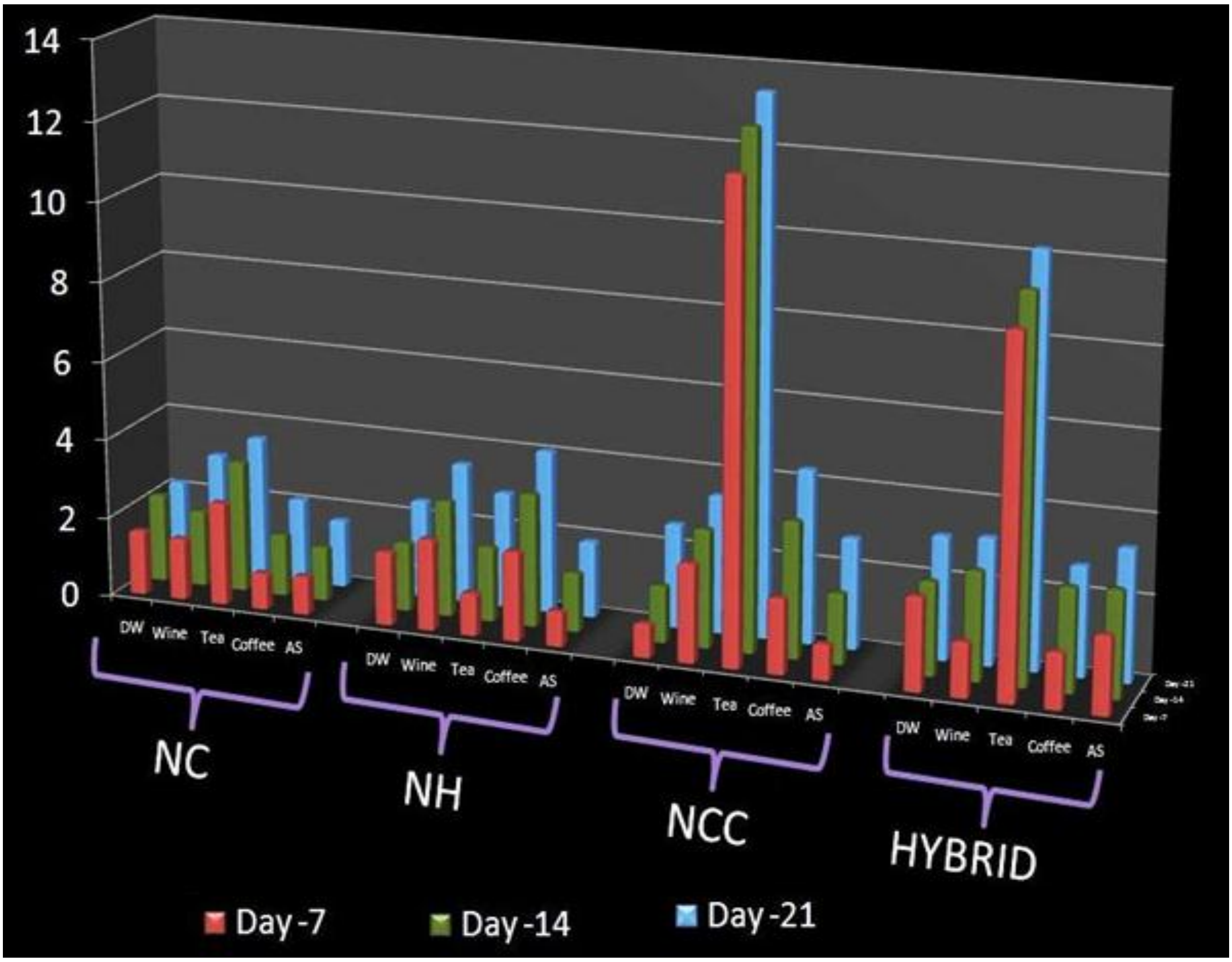
(TABLE V) - MEAN VALUES OF COLOR CHANGE [ΔE] OF DIFFERENT COMPOSITE RESIN GROUP AFTER EXPOSURE COFFEE

Material / Day	NC			NH			NCC			HYBRI	
	ΔL	ΔA	ΔB	ΔL	ΔA	ΔB	ΔL	ΔA	ΔB	ΔL	ΔA
1 WEEK	-0.53	0.08	-0.07	-1.01	-0.21	0.42	-0.68	0.29	1.26	-0.39	-0.28
2 WEEK	-1.24	0.07	0.49	-1.99	-0.35	1.18	-1.83	-0.03	-0.19	-1.12	0.39
3 WEEK	-1.68	0.26	0.78	-2.90	-0.07	1.64	-2.77	2.70	-0.80	-1.84	0.33

(TABLE VI) - MEAN VALUES OF COLOR CHANGE [ΔE] OF DIFFERENT COMPOSITE RESIN GROUP AFTER EXPOSURE ARTIFICIAL SALIVA

Material / Day	NC			NH			NCC			HYBRI	
	ΔL	**ΔA**	**ΔB**	**ΔL**	**ΔA**	**ΔB**	**ΔL**	**ΔA**	**ΔB**	**ΔL**	**ΔA**
1 WEEK	-0.61	0.08	-0.07	-0.36	-0.15	-0.29	-0.47	0.38	-0.17	-1.33	-0.16
2 WEEK	-1.00	0.14	0.49	-1.33	0.05	0.01	-1.36	0.91	0.04	-2.38	0.36
3 WEEK	-1.33	0.26	0.63	-1.74	0.22	0.22	-2.05	1.36	-0.18	-2.99	0.78

GRAPH 1 : COLOR CHANGE IN DIFFERENT COMPOSITES FOLLOWING IMMERSION IN TEST SOLUTIONS AT DIFFERENT TIME INTERVAL



NC – NANO COMPOSITE

NH – NANO HYBRID COMPOSITE

NCC- NANO CERAMIC COMPOSITE

DW – DISTILLED WATER

AS – ARTIFICIAL SALIVA

STATISTICAL ANALYSIS

Statistical analysis was performed by using three way ANOVA followed by TUKEY – KRAMER Post Hoc Tests for multiple pair wise comparison. Statistical software SPSS 15.0 was used for analyzing the data.

TABLE VII – shows mean values of ΔE of various solutions. TABLE VIII of composites and TABLE IX of various week respectively.

TABLE X -THREE WAY ANOVA for ΔE.

TUKEY KRAMER POST HOC TESTS FOR MULTIPLE PAIR WISE comparisons TABLE XI for solution. TABLE XII: shows for composites and TABLE XIII shows for week respectively.

ΔE –Nano ceramic composite discoloured the most [ΔE=13.41] on 3 week in tea. When compairing the mean value among materials there was significant change in Nano hybrid composite and Nano ceramic composite and Nano composite [$p < 0.001$]. However, there was no significant difference between the Nano ceramic composite and Hybrid composite.

PAIR WISE POST HOC TEST

Tukey Kramer post hoc test shows that there is no significant difference in the mean value of discoloration of composites between distilled water and wine [$p = 0.723$]. The mean values in distilled water is 2.06 and in wine is 2.62.

There is significant difference in the mean value between distilled water and tea [p<0.001]. The mean value in tea is 6.85

There is no significant difference in the mean value of discoloration of composites between distilled water and coffee [p=0.801]. The mean value in coffee is 2.55

There is no significant difference in the mean value of discoloration of composites between distilled water and saliva [p=0.977]. The mean value in saliva is 1.80

There is significant difference in the mean value of discoloration of composites between wine and tea [p= 0.001] and no significant difference between wine and coffee [1.000]

The post hoc test results among the mean value of ΔE in different solutions shows that the mean values of Tea significantly differs with Distilled water (P<0.001), Wine (P<0.001), coffee (P<0.001), and Saliva (P<0.001).

[TABLE VII] MEAN VALUES OF ΔE OF VARIOUS SOLUTIONS

Solution	Mean	SD
Distilled Water	2.06	0.81
Wine	2.62	1.80
Tea	6.85	6.68
Coffee	2.55	1.91
Saliva	1.80	1.02

[TABLE VIII] MEAN VALUES OF ΔE OF VARIOUS COMPOSITES

Material	Mean	SD
NANO COMPOSITE	2.05	1.31
NANO HYBRID	2.35	1.43
NANOCERAMIC	4.78	5.86
HYBRID	4.03	4.31

[TABLE IX] MEAN VALUES OF ΔE OF VARIOUS WEEK

Day	Mean	SD
1 WEEK	2.59	3.78
2 WEEK	3.35	3.94
3 WEEK	3.99	3.96

[TABLE X] THREE WAY ANOVA FOR ΔE

Source	Mean Square	F	P-value.
Solution	497.354	65.821	<0.001
Material	172.924	22.885	<0.001
Day	74.415	9.848	<0.001

[TABLE XI]: TUKEY – KRAMER POST HOC TESTS FOR MULTIPLE PAIR WISE COMPARISONS FOR SOLUTION

(I) Solution	(J) Solution	P - value
Distilled Water	Wine	0.723
	Tea	<0.001
	Coffee	0.801
	Saliva	0.977
Wine	Distilled Water	0.723
	Tea	<0.001
	Coffee	1.000
	Saliva	0.151
Tea	Distilled Water	<0.001
	Wine	<0.001
	Coffee	<0.001
	Saliva	<0.001
Coffee	Distilled Water	0.801
	Wine	1.000
	Tea	<0.001
	Saliva	0.215
Saliva	Distilled Water	0.977
	Wine	0.151
	Tea	<0.001
	Coffee	0.215

[TABLE XII]: TUKEY – KRAMER POST HOC TESTS FOR MULTIPLE PAIR WISE COMPARISONS FOR COMPOSITES

(I) Material	(J) Material	P - value
NC	NH	0.814
	NCC	<0.001
	Hybrid	<0.001
NH	NC	0.814
	NCC	<0.001
	Hybrid	<0.001
NCC	NC	<0.001
	NH	<0.001
	Hybrid	0.115
Hybrid	NC	<0.001
	NH	<0.001
	NCC	0.115

NC – NANO COMPOSITE

NH – NANO HYBRID COMPOSITE

NCC – NANO CERAMIC COMPOSITE

HYBRID COMPOSITE

[TABLE XIII]: TUKEY – KRAMER POST HOC TESTS FOR MULTIPLE PAIR WISE COMPARISONS FOR WEEK

(I) WEEK	(J) WEEK	P - value
1 WEEK	2 WEEK	0.025
	3 WEEK	<0.001
2 WEEK	1 WEEK	0.025
	3 WEEK	0.071
3 WEEK	1 WEEK	<0.001
	2 WEEK	0.071

Discussion

DISCUSSION

Significant improvements in tooth-colored restorative materials and adhesive techniques have resulted in numerous conservative esthetic treatment possibilities. Although restorative dentistry has enjoyed the distinction of being a blend of art and science, conservative esthetic dentistry truly emphasizes the artistic component. As Dr.Ronald E. Goldstein states, "Esthetic dentistry is the art of dentistry in its purest form."'- 'As with many forms of art, conservative esthetic dentistry provides a means of artistic expression that feeds on creativity and imagination[42] .Dentists find performing conservative esthetic procedures to be most enjoyable, and patients appreciate the immediate esthetic improvements rendered, often without the need for local anesthesia.

Composite restorative materials consist of a continuous polymeric or resin matrix in which an inorganic filler is dispersed. This inorganic filler phase significantly enhances the physical properties of the composite (as compared to previous tooth-colored materials) by increasing the strength of the restorative material and reducing the linear coefficient of thermal expansion .

Conventional composites generally contain approximately 75% to 80% inorganic filler by weight. The average particle size of conventional composites in the 1980s was approximately 8 μm. Because of the relatively large size and extreme hardness of the filler particles, conventional composites typically exhibit a rough surface texture. The resin matrix wears at a faster rate than the filler particles, further roughening the surface. This type of surface texture causes the restoration to be more susceptible to discoloration from extrinsic staining .

Hybrid Composites. These materials generally have an inorganic filler content of approximately 75% to 85% by weight. The filler is typically a mixture of microfiller and small filler particles that results in a considerably smaller average particle size (0.4 to 1 μm) than that of conventional composites. Because of the relatively high content of inorganic fillers, the physical and mechanical characteristics are generally superior to those of conventional composites.

New composites are being developed with nanofillers that range in size from 0.005 to 0.01 μm, which is below the wavelength range for visible light (0.02 to 2 μm).Because these particles do not interact with visible light, they do not produce scattering or significant absorption. Nonsilicate-based compositions can be used for nanofillers because they are effectively invisible. Nanofillers are so small that they fit between several polymer chains. These characteristics permit the opportunity to achieve very high filler loading levels in composites while still maintaining workable consistencies.

As tooth-colored restorative dental materials are continuously exposed to saliva, beverages and food stains in the oral environment, it is important to determine their susceptibility to color change. The discolouration of tooth coloured resin based composite materials can be a reason for the replacement of dental restorations in aesthetic areas. To ensure restorations' imperceptibility both intrinsic color stability and staining resistance over a long period in the oral environment are necessary[34]. Although clinical studies require long-term evaluation periods to achieve results, several laboratory tests have been used in order to simulate and accelerate the discoloration, simulating oral aging conditions [21]

Discoloration of composite resins can be induced internally or externally. In visible light-cured composite resin system, camphorquinone is generally used as the photoinitiator. However, if curing is inadequate,unconverted camphorquinone will cause a yellowish discoloration. Further, other components of the photoinitiator system — namely tertiary aromatic or aliphatic amines which act as so-called synergists or accelerators, they also tend to cause yellow or brown discoloration under the influence of light or heat [2]

. These are internally induced discolorations which are permanent and which are related to polymer quality, filler type and amount, as well as the synergist added to the photoinitiator system.[28]

As dental practitioners cannot interfere in nor meddle with the content of composite resins, internal discoloration depends on the manufacturer's formulations, except due to improper light curing.In the oral environment, be it superficial degradation or a slight penetration and adsorption of staining agents at the superficial layer of composite resins, it can cause discoloration of the surface or subsurface of resin restorations [46]

The resin's affinity for extrinsic stains is modulated by its conversion rate and physico-chemical characteristics — with water sorption rate being of particular importance [20,48]. Other important factors that affect stainability are surface roughness, surface integrity, and polishing technique.

Previous studies have reported that extrinsic factors such as adsorption or absorption of staining agents such as red wine,coffee, tea, and cola may cause discolouration [19].Oral habits such as tobacco use and certain dietary patterns (for example, caffeine intake) may exacerbate the external discolouration of resin based composites.

Red wine, coffee, tea, and cola have been proven to play a significant role in causing discolouration of composite resins through the act of adsorption or absorption .Staining also depends on the type of solutions and the composition of each solution which are different.

For this in vitro study, the color of four composite resin discs [Group A – Nanocomposite resin -- NC, Group B - Nano hybrid composite resin— NH,Group C - Nano Ceramic composite – NCC ,Group D - Hybrid composite resin— HC] was measured after four different immersion times: at baseline (immersion in distilled water for 24 h) and, after 1-week ,2 week and 3 week immersion in three popularly consumed beverages [tea, coffee, wine]. Artificial saliva was to check how these composite materials will behave when placed orally.

To simulate the clinical discoloration potential of the composites, the samples were stored at 50°C in accordance with the accelerated lab test given by Asmussen (1983) which stated that the color changes produced in composites by storing for one month at an increased temperature of 50-60°C was well correlated with color change obtained after storing for 12 months at 37°C[6] When measuring reflective surfaces, the measured color will depend on both the actual colors of the surface and the lighting conditions under which the surface is measured. In the present study, a standard illuminant A (incandescent light) against a white background [white card] was used. Color coordinates presented in color studies are generally the values over white backgrounds, although background is not mentioned in some studies. Since the color of natural teeth is basically white-based, these reported values would be clinically relevant.

Thickness and smoothness of the specimen surface also affect color. In the present study, the thickness of composite restorative material disk was prepared as 2.5 mm. In a study it was stated that since the color difference between the 2.5 and 3.0mm thick specimens were the lowest ($\Delta E°ab < 2.0$), a thickness of atleast 2.5mm was found to be required for the acceptable color reproduction of composite materials. Although the concept determined in this study was different from that of the infinite optical thickness, this thickness threshold would be used as a recommended thickness for color specimens.[53]

Color reproduction of esthetic restorative materials by thickness is evaluated based on four visual categories for color perception such as perfect reproduction, not-perceptible reproduction, acceptable reproduction and not acceptable reproduction. If the thickness is thicker than the infinite optical thickness, perfect reproduction of the assigned color would be possible. If thinner than this value, perceptibility or acceptability in color reproduction should be evaluated. Considering these, a minimum thickness of 2.5mm [23] could be a guideline for the acceptable color reproduction.

Measurement area (aperture size) of an instrument influences the instrumental color. When color is measured with an instrument that has a small window for both illumination and collection of light,a considerable fraction of the light entering thespecimen is probably lost. [49] To minimize the edge loss effect, the diameter of the specimens（10 mm）prepared in this study was greater than the aperture size of the instrument（8 mm）. All measurements of composite disk were done using the same measuring geometry. The instrument was placed in 0° viewing angle geometry for taking color change measurement.

The finishing and polishing procedures also influence the composite surface quality and are therefore linked to the early discoloration of resin composites. In this study no polishing was done as it has been shown that composite polymerized against mylar strips have greater smoothness and lustre than when polishing disks/wheels are used and is considered as gold standard against which other polishing instruments are evaluated.[14]

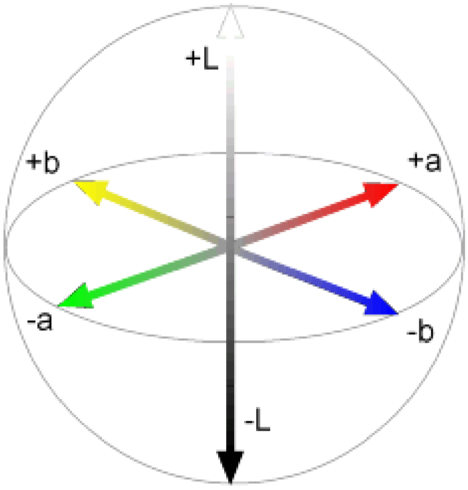
Color stability has previously been studied in vitro for a variety of aesthetic restorative materials.[51,43] Discolouration can be evaluated visually or by instrumental techniques.[26] The system for measuring chromacity was chosen to record color differences because it is well suited for the determination of small colour differences.[3] Tristimulus colorimeters are capable of detecting colour differences below the threshold of visual perception. The value of ΔE^* represents relative colours changes that an observer might report for the materials after immersion or between time periods. Thus ΔE^* is more meaningful than the individual L^*, a^*, b^* values

James Clerk Maxwell is credited with being the first to quantitatively measure human color matching functions, the basis of modern colorimetry[6]. Maxwell's pioneering work ultimately led to the 1931 establishment of the CIE (Commission Internationale de L'Eclairage, or International Commission on Illumination) system of colorimetry as specified by the CIE 1931 Standard Colorimetric Observer and CIE Illuminants A, B, and C along with procedures for their implementation and application.

The color measurements in the present study was carried out using a reflectance spectrophotometer, as color perception is a psychophysical phenomenon with variations, both between individuals and within an individual at different times and instrumental measurement has the advantage of obviating the subjective errors of color assessment.Tristimulus colorimeters have been found to have precision for in-vitro measurements of color and color differences. Therefore standard Commission Internationale de l'eclairage (CIELAB) color system was used to express the magnitude of color and relative color changes of all the specimens.

The CIE L*A*B* color system used in this study is a recommended method for dental Purposes[11]. It designates color according to 3 spatial coordinates, L*, A*, B*.

CIELAB COLOR AXIS



The CIE L^* coordinate ranges from 0 to 100 and represents the lightness;

The CIE A^* coordinate ranges from −90 to70 and represents greenness (positive A^*) and redness(negative A^*);

The CIE B^* coordinate ranges from −80 to100 and represents yellowness (positive B^*) and blueness(negative B^*) .

The advantage of this system over the Munsell system (hue, chroma and value color attributes) is that the CIE color coordinates are evenly spaced in terms of visual perception, so that the spectral readings can be correlated with subjective observations.[1]

In principle if a material is completely color stable, no color difference will be detected after its exposure to the testing environment ($\Delta E = 0$). The human eye cannot detect ΔE values of less than 1.5, although this value is measurable with the help of spectrophotometer.In the present study ΔE values equal to or greater than 3.3 were considered clinically perceptible, based on previous reports.

In our study among composite materials

ΔE –Nano ceramic composite discoloured the most [ΔE=13.41] on 3 week in tea. The presence of methacrylate modified polysiloxane might have increased chances of discoloration as it has been reported that siloxane is susceptible for fluid [water] penetration as there are different types of fillers used in this material. This could be also due to the nature of the resin matrix and the possible porosity in aggregated filler particles as well as the porosity of the glass fillers. As this is a newly introduced material so future research has to be done regarding its physical properties like color changes.

Second was hybrid composite in tea on 3 week [ΔE= 10.23]

Third was nano hybrid composite in coffee on 3 week [ΔE= 4.10]

Nano composite showed minimum discoloration in this study.

The staining observed in studies are usually those that occur on the surface. This is because of the hydrophobic monomers in composite resins.[57] UDMA based monomers display lower staining values compared to other dimethacrylate based monomer types. This may be accounted for low viscosity and low water absorption of urethane dimethacrylate and its successful polymerization with visible light.

It was found that incorporation of greater amounts of TEGDMA resulted in an increase in water uptake in Bis-GMA based resins,[58] and Tarumi et al[59] reported that this was due to increased surface hydrophilicity. Hydrophilic groups such as the ethoxy group in TEGDMA are thought to show affinity with water molecule by hydrogen bonding to oxygen.

An explanation for the differences in optical properties due to water exposure might be found in the materials' composition and the way they are affected by environmental conditions. It is known from recent studies that resin-based composites allow water penetration to matrix or filler-matrix interface. As it is assumed that the resin component is a source of discolouration,one would expect that a high volume fraction of the resin correlates with a high prospect for discolouration.

In our study maximum discoloration was found due to tea.

The staining ability of tea could be due to the presence of tannic acid[56]. This result is similar to a study done by Moon, Eystein and Ruyter (1991) on staining of resin based veneering materials with three heat cured and two light cured resins as test materials which showed more discoloration by tea in comparison to coffee over an observation period of 48 hours. [34] Both tea and coffee contained yellow colorants which had different polarities.

Next solution was coffee. Higher polarity components （like those in tea） were eluted first, while lower polarity components（like those in coffee） were eluted at a later time. Discoloration by tea due to adsorption of polar colorants onto the surface of resin composite materials could be removed by tooth brushing, whereas discoloration by coffee was due to both absorption and adsorption of polar colorants onto the surface of materials. This adsorption and penetration of colorants into the organic phase of the materials were explained by the authors as probably due to compatibility of the polymer phase with the yellow colorants of coffee. Further, the findings of Bagheri et al.[8] also lent support to the present study in that coffee, tea, and red wine caused more discoloration than soy sauce and cola .Thus between different solutions Tea caused the highest discoloration followed by coffee, wine , distilled water and artificial saliva.

In our study wine caused less discoloration than tea and coffee which might be due to composition of wine,which is not known, as it was a brand from local brewery and was fortified port wine . Several studies have reported that alcohol facilitates staining by softening the resin matrix of the composites.[34,17]

Distilled water and saliva was also found to cause small variations in color which may be due to increased temperature, causing increased water uptake by the materials and leaching out of few soluble components of the materials but the total color change [ΔE] in all the time period was not clinically perceptible[below 3.3].

In distilled water all materials showed values below 3.3 . Color change is imperceptible and clinically acceptable.

In wine NCC showed values of 3.46 which is above 3.3. Color change is perceptible and clinically unacceptable.

In tea Nano composite showed greater value [3.61]. Color change is perceptible and clinically unacceptable.

In tea Nano ceramic composite,Hybrid composite showed values above 3.3. Color change is perceptible and clinically unacceptable.

In coffee Nano hybrid showed increased values after 2 and 3 week. Color change is perceptible and clinically unacceptable.

In artificial saliva all values were below 3.3 making color change is imperceptible and clinically acceptable.

It has been claimed that under clinical conditions in the mouth ΔE color differences have been reported as relevant only when the value is higher than 3.3 . Thus the changes in the composites are of relevance clinically as these changes would be apparent after prolonged and frequent exposure of the restorations to tea, coffee and wine.

From the present in-vitro study, it can be concluded that the popularly consumed beverages like tea, coffee and wine have the ability to discolor composite resin restoration in duration of time however, that the color match of esthetic restorations can be maintained over a longer period of time in the oral cavity by observing some restrictions on the dietary habits.

Summary

SUMMARY

Two hundred disc samples (50 disk of each material of 10 mm diameter and a thickness of 2.5 mm) of shade A3 were fabricated by condensing the composite materials into ring shaped Teflon moulds by using Teflon coated instrument.

No polishing technique was used to avoid modification of the surfaces,which may have influenced the results.

They were divided into 4 groups: Nanocomposite resin -- NC, Nano hybrid composite resin—NH,Nano Ceramic composite – NCC ,Hybrid composite resin— HC

The prepared composite disks were placed in distilled water and the specimens were incubated in 100% humidity at 37°C for 24 hours in an incubator.

The base line color values [L,A,B] of each specimen were measured with a spectrophotometer according to Commission Internationale d'Eclairage [CIELAB]. The spectrophotometer was calibrated with a standard white card before each group of specimen was measured,and the card was used as a background when measuring all specimens.

After baseline color measurements, discs were immersed in staining solutions of tea, coffee, wine ,artificial saliva and in distilled water [control] and measurements were made after 1week, 2 week and after 3 weeks.

Using the values of L*, A*, B*, differences between the first measurement and the time-dependent measurements were calculated as the color difference values ΔL*, ΔA* and ΔB*.

For example, the formula for ΔL* was as follows:

$\Delta L^*(t) = L^*(t) – L^*(0)$

To derive an overall color change, ΔE(t) at time *t* was calculated as follows according to CIE :

$\Delta E= [(\Delta L^*)^2+ (\Delta A^*)^2+ (\Delta B^{*2})]^{1/2}$

Mean values of the different groups were compared using three way analysis of variance and multiple comparisons of the mean values were done using Tukey–Kramer Post Hoc Tests . In the present study, $p < 0.05$ was considered as the level of significance.

Conclusion

CONCLUSION

Under the conditions of the present in vitro study, following conclusions can be drawn :

- Tea ,coffee, wine used in the present study affect the color stability of tested resin composites and the color changes produced are visually perceptible and not clinically acceptable ($\Delta E > 3.3$).
- Following immersion period of 1 ,2 and 3 weeks it was found to be that the highest value of ΔE was observed in Nano ceramic composite on immersion in tea followed by Hybrid composite in tea.
- Highest discoloration of Nano hybrid composite was found in coffee after immersion after 3 week.
- Nano composite showed minium discoloration of all tested composite materials but showed highest discoloration after immersion in tea.

It is difficult to entirely correlate laboratory findings with the clinical behavior of any restoration, since a number of factors are at play in oral environment and therefore to find a correlation between clinical studies and lab measurements, further in-vivo clinical assessment will be ideal to conclude.

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